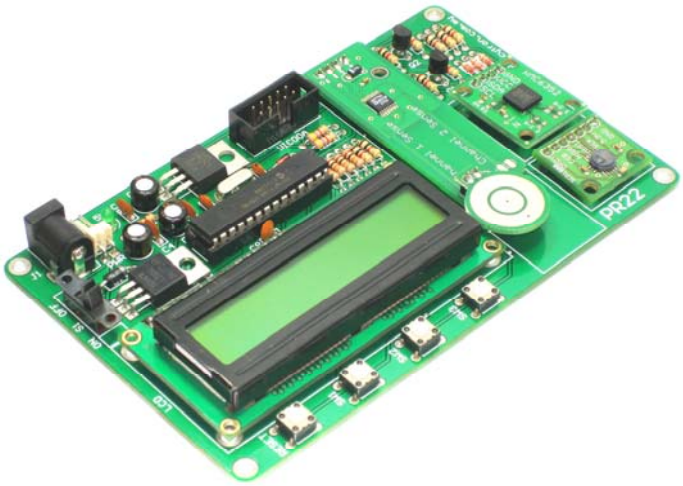
PR22

Reading Compass Module, Capacitive And Barometric Pressure Sensors



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Cytron Technologies Sdn. Bhd.

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OVERVIEW

This document describes the development of Cytron Technologies DIY (Do It Yourself) Project No.22 (PR22). This project will use PIC16F876A, capacitive sensor, compass module, barometric pressure sensor and LCD. The function of the circuit is to read capacitive sensor, compass module and barometric pressure sensor, and display the readings on LCD. Circuit schematic and PIC source code will be provided.

FEATURES

PIC16F876A
- 8-bit microcontroller with 22 I/O
- Operates with 5V supply

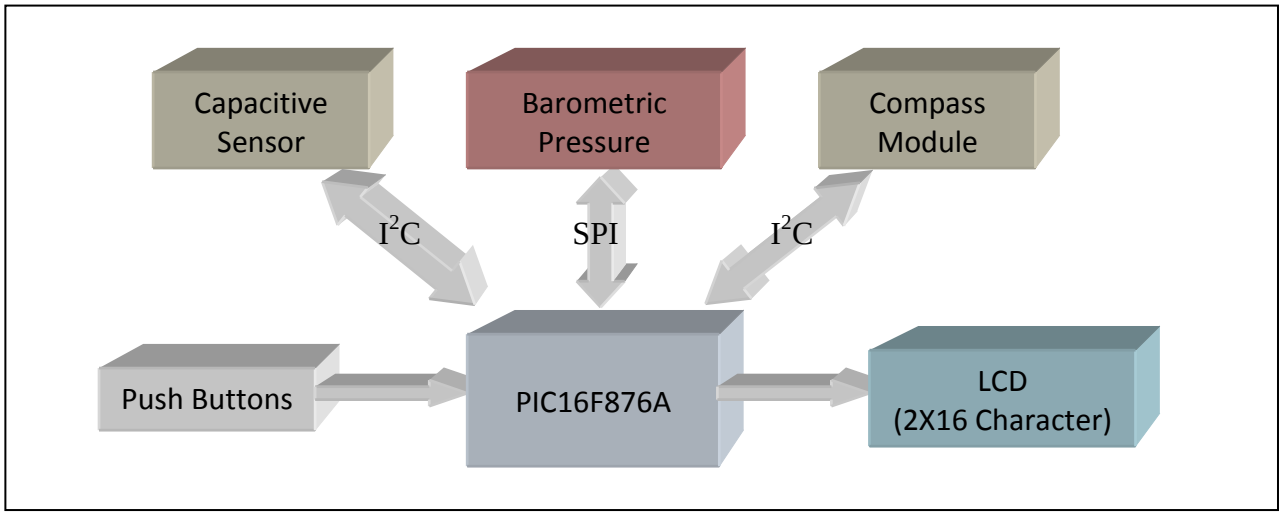
LCD (2X16 characters)
- 2X16 characters display
- Operate at 5V supply

Compass Module (Optional)
- Works in strong magnetic field environments
- Operates at 3.3V supply

Capacitive Sensor (Optional)
- Includes temperature sensor
- Operates at 3.3V supply

Barometric Pressure Sensor (Optional)
- Includes temperature sensor
- Operates at 3.3V supply

SYSTEM OVERVIEW



GENERAL DESCRIPTION

Capacitive Sensor (AD7746)

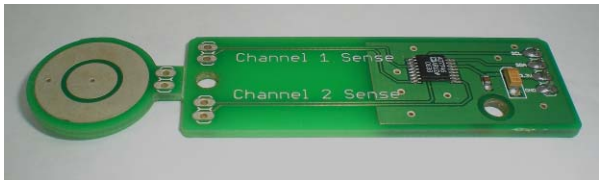


Figure 1

AD7746 is a high resolution capacitance to digital converter (CDC). The capacitance to be measured is connected directly to the device inputs. The AD7746 has two channels capacitance input channels. The part has an on-chip temperature sensor with a resolution of 0.1ºC and accuracy of ±2ºC. The AD7746 has a 2-wire, I²C-compatible serial interface.

Features:

- Capacitance-to-digital converter with full scale range: ±4 pF
- Temperature sensor on-chip
- Voltage input channel
- Internal clock oscillator
- 2-wire serial interface (I²C®-compatible)
- Power: 2.7V to 5.25V single-supply operation
- Operating temperature: -40ºC to +125ºC

Applications:

Automotive, industrial, and medical systems for

- Pressure measurement
- Position sensing
- Level sensing
- Flowmeters
- Humidity sensing
- Impurity detection

For more information about Capacitive Sensor, please refer to the datasheet of the Capacitive Sensor.

Compass Module (HMC6352)

Figure 2

The Honeywell HMC6352 is a fully integrated compass module that combines 2-axis magneto-resistive sensors with the required analog and digital support circuits, and algorithms for heading computation.

Features:

- Compass with Heading Output
- Full integration of 2-axis magnetic sensors and electronics
- Firmware included
- Low voltage operation (2.7V to 5.2V)
- I²C 2-wire serial interface

Applications:

- Wireless phones
- Consumer electronics
- Vehicle compassing
- Antenna Positioning

For more information about Compass Module, please refer to the datasheet of the Compass Module.

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Barometric Pressure Sensor (SCP1000-D01)

Figure 3

SCP1000 is pressure sensor that measures absolute pressure. The SCP1000 performs almost complete data processing on-chip. The pressure and temperature output data are calibrated and compensated internally.

Features:

- 30kPa – 120kPa measuring range
- Single +2.4 … 3.3V supply
- Four measuring modes plus power down mode
- On-chip temperature measurement
- Fully calibrated and compensated component
- Standard digital output: SPI

Applications:

- Barometric pressure measurement and altimeter applications
- Home weather stations
- Advanced medical applications
- Level gauging

For more information about Barometric Pressure Sensor, please refer to the datasheet of the Barometric Pressure Sensor.

PIC16F876A

This powerful (200 nanosecond instruction execution) yet easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC® architecture into an 28-pin package and is upwards compatible with the PIC16C5X, PIC12CXXX and PIC16C7X devices. Feature of the device:

- 256 bytes of EEPROM data memory
- Self programming
- ICD (In Circuit Debugging function)
- 2 Comparators
- 5 channels of 10-bit Analog-to-Digital (A/D) converter
- 2 capture/compare/PWM functions
- The synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus
- Universal Asynchronous Receiver Transmitter (UART)

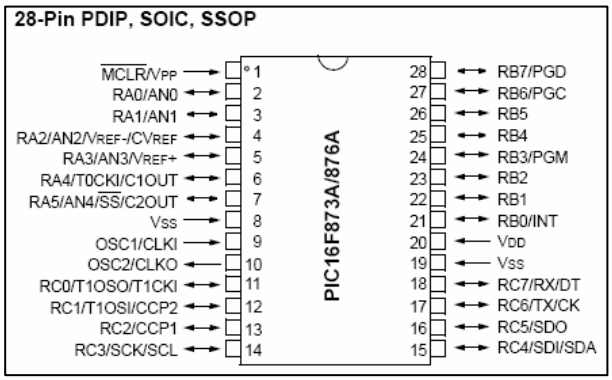


Figure 4

Figure 4 shows the pin diagram for PIC16F876A. For more information about the PIC microcontroller, please refer to the datasheet. The datasheet can be found in microchip web site at: http://www.microchip.com

HARDWARE

This project will require following hardware:

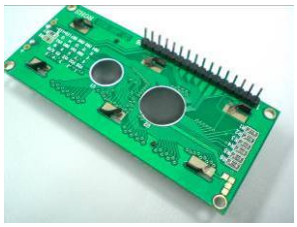
a. 1 x PIC16F876A
b. 1 x PR22 Printed Circuit Board (PCB)
c. 1 x LCD (2X16 character)
d. Related electronic components

(Optional)
e. 1 x Capacitive Sensor (AD7746)
f. 1 x Barometric Pressure Sensor (SCP1000-D01)
g. 1 x Compass Module (HMC6352)

Please refer to Appendix A for the board layout of PR22. The board layout is provided free therefore Cytron Technologies will not be responsible for any further modification or improvement.

Interface LCD (2 x 16 characters) with PIC16F876A

To use the LCD display, users have to solder 16 pin header pin to the LCD display. LCD used in this project is JHD162A, for other type of LCD, please refer to its data sheet.



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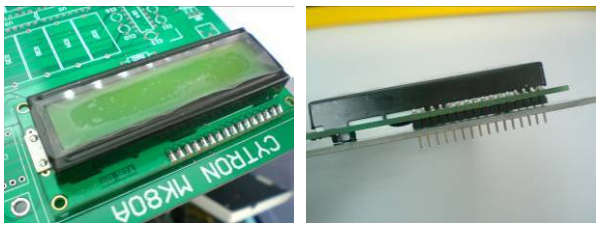

Figure 5

Figure 5 is a 2X16 character LCD. LCD connection pin and function of each pin is shown:

Pin	Name	Pin function	Connection
1	VSS	Ground	GND
2	VCC	Positive supply for LCD	5V
3	VEE	Brightness adjust	RC1
4	RS	Select register, select instruction or data register	RC0
5	R/W	Select read or write	GND
6	E	Start data read or write	RA5
7	DB0	Data bus pin	RB0
8	DB1	Data bus pin	RB1
9	DB2	Data bus pin	RB2
10	DB3	Data bus pin	RB3
11	DB4	Data bus pin	RB4
12	DB5	Data bus pin	RB5
13	DB6	Data bus pin	RB6
14	DB7	Data bus pin	RB7
15	LED+	Backlight positive input	RC2
16	LED-	Backlight negative input	GND

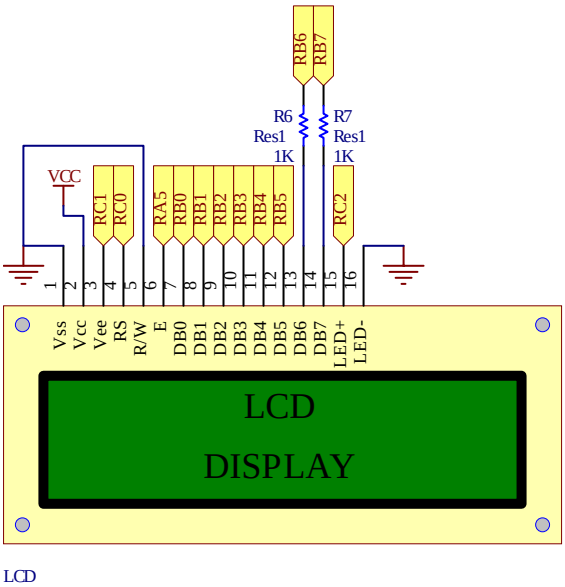

Figure 6

Interface Capacitive Sensor with PIC16F876A

To use the capacitive sensor, users have to solder 4 pin header pin to the sensor.

Capacitive Sensor:

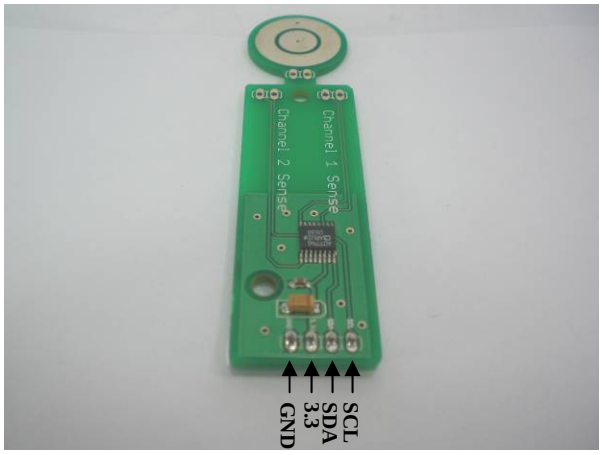

Figure 7

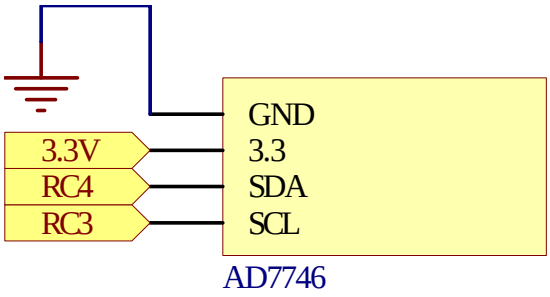

Figure 8

The capacitive sensor needs a 3.3V supply to operate. The RC4 and RC3 pins are SDA pin and SCL pin of PIC16F876A which require pull-up resistors. Refer to **I²C interface of PIC16F876A (3.3V)** section.

Interface Compass Module with PIC16F876A

To use the compass module, users have to solder 4 pin header pin to the module.

Compass Module:

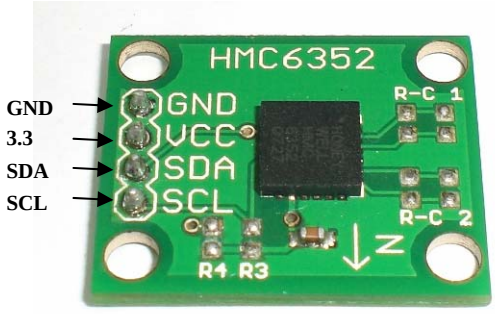

Figure 9

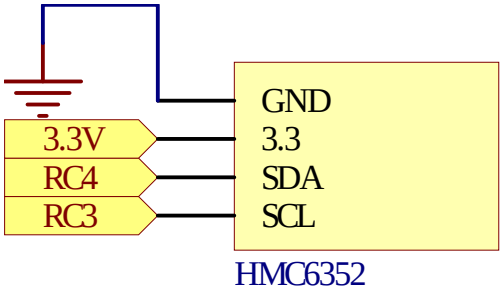

Figure 10

The compass module requires 3.3V supply to operate. The RC4 and RC3 pins are SDA pin and SCL pin of PIC16F876A which require pull-up resistor. Refer to **I²C interface of PIC16F876A (3.3V)** section.

Interface Barometric Pressure Sensor with PIC16F876A

To use the barometric pressure sensor, users have to solder 7 pin header pin to the sensor.

Barometric Pressure Sensor:

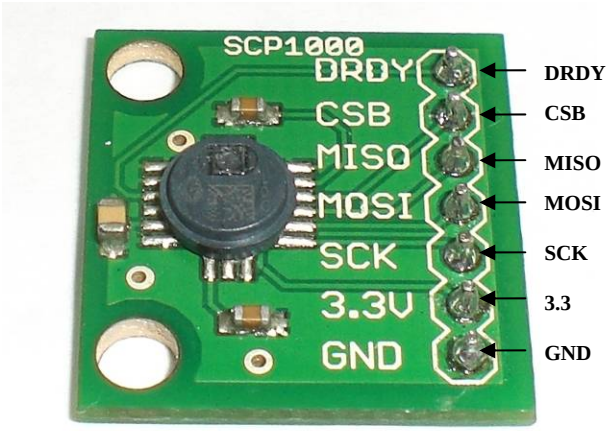

Figure 11

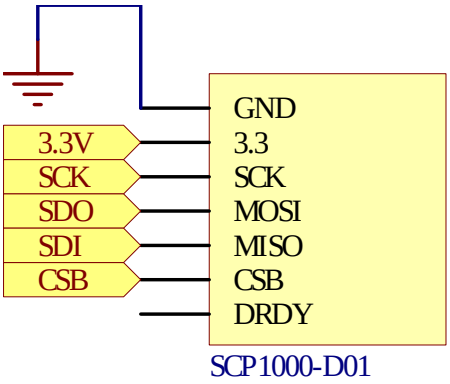

Figure 12

The barometric pressure sensor requires 3.3V supply to operate. The SCK, MOSI, MISO and CSB pins' logic 1 is 3.3V. Thus it requires conversion of 5V signal from PIC16F876A to 3.3V. Refer to **SPI interface of PIC16F876A (3.3V)** section. The status of DRDY pin can be read from SPI bus and thus is left not connected.

Power supply for circuit

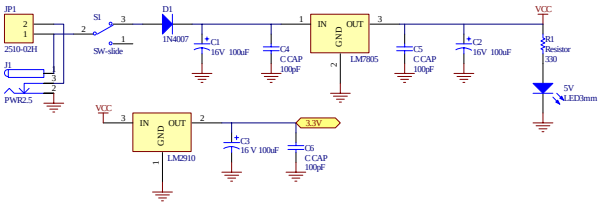

Figure 13

User can choose either AC to DC adaptor (not included in the DIY project set) or 9V-12V battery (not included in the DIY project set) to power up the circuit. Higher input voltage will produce more heat at LM7805 voltage regulator. Typical voltage is 12V. Anyhow, LM7805 will still generate some heat at 12V. There are two type of power connector for the circuit, DC plug (J1) and 2510-02H (Power Connector). Normally AC to DC adaptor can be plugged to J1 type connector.

Refer to Figure 13, the D1 is use to protect the circuit from wrong polarity supply. C1 and C4 are used to stabilize the voltage at the input side of the LM7805 voltage regulator, while the C2 and C5 are used to stabilize the voltage at the output side of the LM7805 voltage supply. The "5V" is a green LED to indicate the power status of the circuit. R1 is resistor to protect LED from over current which might burn LED. The output of LM7805 is connected to input of LM2910 3.3V voltage regulator as supply. The output of LM2910 is stabilized by C3 and C6.

Push Button as input of PIC microcontroller

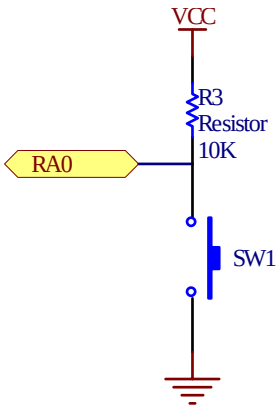

Figure 14

One I/O pin is designated for a push button as input to PIC microcontroller. The connection of the push button to the I/O pin is shown in Figure 14. The I/O pin should be pull up to 5V using a resistor (with value range 1K-10K) and this configuration will result an active-low input. When the button is being pressed, reading of I/O pin will be in logic 0. Meanwhile the button is not pressed, reading of that I/O pin will be logic 1.

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ICSP for programming PIC microcontroller

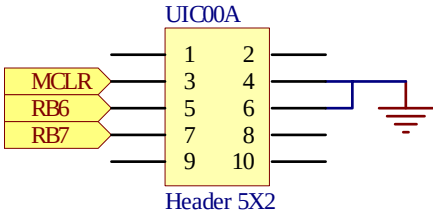

Figure 15

MCLR, RB6 and RB7 need to be connected to the USB In Circuit Programmer (UIC00A) to program the PIC microcontroller. The programmer (UIC00A) is not included in DIY project set since it can be used several time for different project set. User can also choose other type of PIC programmer to load the program.

For the instruction of using PIC programmer, please refer to the particular PIC programmer user's manual.

I²C interface of PIC16F876A (3.3V)

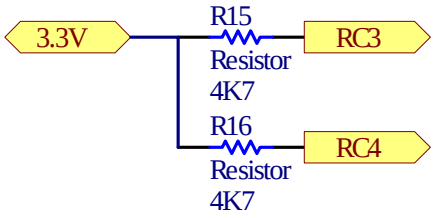

Figure 16

When the MSSP module of PIC16F876A is configured as I²C mode, RC3 and RC4 pins become bidirectional ports. SCL (RC3) and SDA (RC4) lines must have an open drain in order to perform the wired-AND function of the bus. External pull-up resistors are used to ensure a high level when no device is pulling the line down.

SPI interface of PIC16F876A (3.3V)

The MSSP module can be configured as either I²C or SPI mode only. Since it has been configured as I²C mode for capacitive sensor and compass module, a manual control protocol must be created to communicate with barometric pressure sensor which using SPI protocol. There are 4 pins required by SPI protocol, that are SCK (serial clock), SDO (serial data master out, slave in), SDI (serial data master in, slave out) and CSB (chip select – enable slave). SCK, SDO and CSB are outputs from PIC16F876A whereas SDI is input for PIC16F876A. Since SCP1000-D01 operates at 3.3V, any signal between it and PIC16F876A must be converted to voltage level that is applicable by the other. For manual control, the RC5 is programmed as SDI, RC6 is programmed as SCK, RC7 is programmed as SDO and RA3 is programmed as CSB. The following figures show the circuits for conversion.

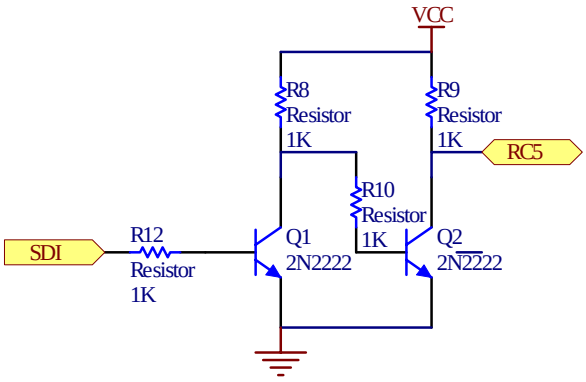

Figure 17: 3.3V (SDI) to 5V (RC5)

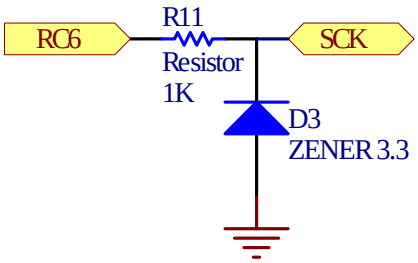

Figure 18: 5V (RC6) to 3.3V (SCK)

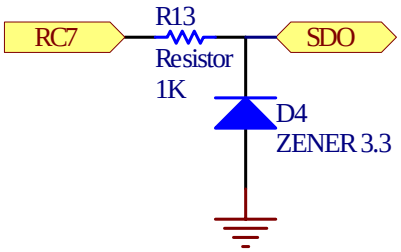

Figure 19: 5V (RC7) to 3.3V (SDO)

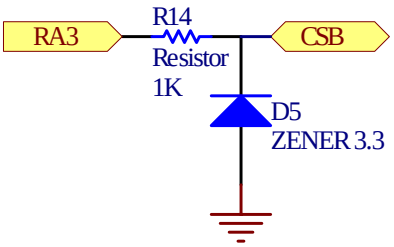

Figure 20: 5V (RA3) to 3.3V (CSB)

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PCB circuit board

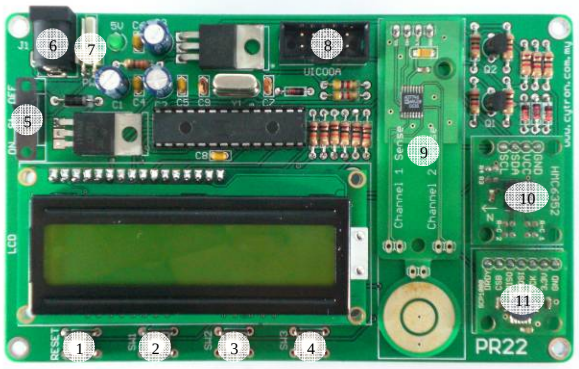


Figure 21

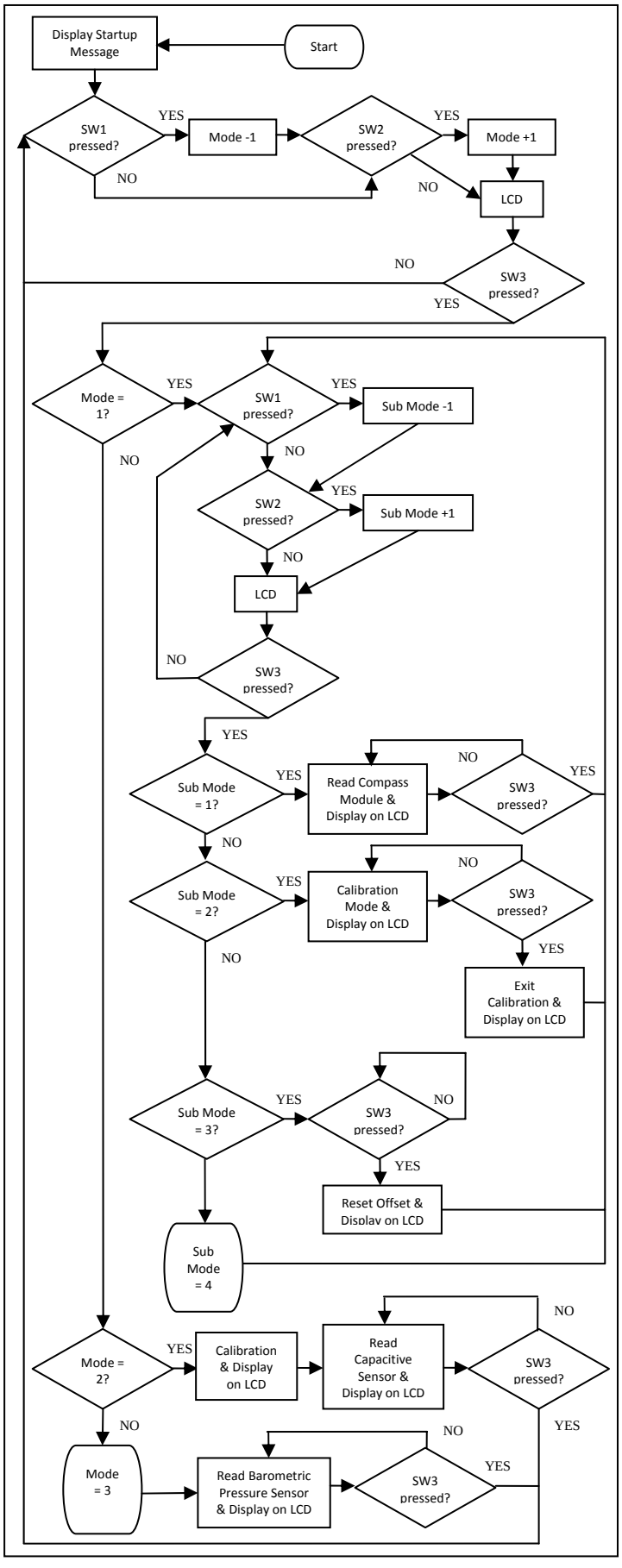
Component:

1. RESET button.
2. SW1 button.
3. SW2 button.
4. SW3 button.
5. S1 Slides switch (Circuit Power ON/OFF).
6. DC plug socket (To 7-12V AC to DC adaptor).
7. Power connector (7-12V).
8. Box header (To ICSP programmer).
9. AD7746 Capacitive Sensor.
10. HMC6352 Compass Module.
11. SCP1000-D01 Barometric Pressure Sensor.

Please refer to Appendix A for the PCB layout of PR22. The PCB layout is provided free therefore Cytron Technologies will not be responsible for any further modification or improvement.

SOFTWARE

Flow Chart:



For AD7746 capacitive sensor, channel 1 is selected by default. To select the channel 2 as input, please modify the code as stated in the program.

For more information about the software for this system, please refer to the source code provided. The explanation of each instruction is provided in the source code as the comment of each line.

The source code is provided free and Cytron Technologies will not be responsible for any further modification or improvement.

GETTING START

User can obtain the hardware set for this project (PR22) either by online purchasing (www.cytron.com.my) or purchase it in Cytron Technologies Shop.

1. Once user has the hardware set, soldering process can be started. Please solder the electronic components one by one according the symbols or overlays on the Printed Circuit Board (PCB). Ensure the component value and polarity is correctly soldered. Please refer to PCB Layout in Appendix A.

Caution: Make sure all the connectors (2510) are soldered in proper side. Those electronic components have polarity such as capacitor, diode, PIC, LM7805, LM2910, transistor and LED should be soldered in right polarity or it may cause the circuit board fail to work.

Warning: Before the battery (Power) is plugged in, make sure the polarity is correct to prevent the explosion. Wrong polarity of capacitor also may cause explosion.

For AD7746, user can connect the pad to the channel input as shown in figure 22 below.

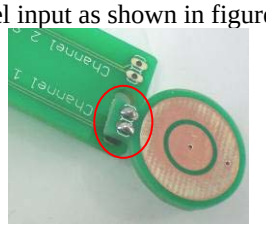


Figure 22

2. Please download the necessary files and document from Cytron Technologies website. These included documentation, sample source code, schematic, component list and software.

3. The next step is to install MPLAB IDE and HI-TECC C PRO into a computer. The MPLAB IDE and HI-TECC C PRO can be downloaded from www.cytron.com.my . Please refer MPLAB IDE installation step document to install the software. The documents can be used to any version of MPLAB IDE software.

4. After the installation complete, open the project file provided using MPLAB IDE. Please refer MPLAB Open Project document to open the sample program.

5. Plug in power supply for the circuit. User can choose to use battery or AD to DC adaptor.

AC to DC adaptor:

Figure 23 (not included in DIY project set)

9V battery connector:

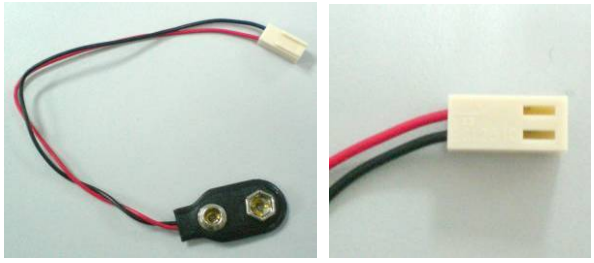


Figure 24 (not included in DIY project set)

Connection to the PCB board:

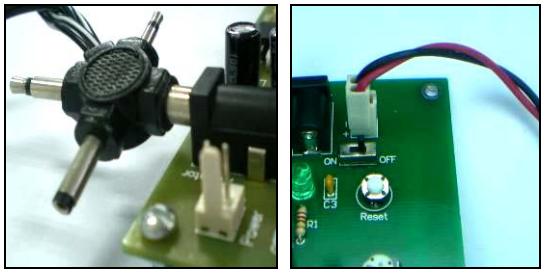


Figure 25

6. Build the project and load the hex file into the PIC microcontroller using the USB In Circuit Programmer (UIC00A). When user build the project, MPLAB IDE will generate hex file. The hex file generated from MPLAB IDE will be named according to project name, not C file name. Cytron Technologies also provide hex file for user. Do not forget to switch ON the power. The programmer is not included in the hardware set but it can be found at Cytron website. (User manual is provided at website).

7. Test the functionality of the Compass Module, Capacitive Sensor and Barometric Pressure

Sensor. Use SW1 and SW2 to change the mode (sensor), and SW3 to enter the mode.

8. Modify the program.

9. Have fun!

Test Method

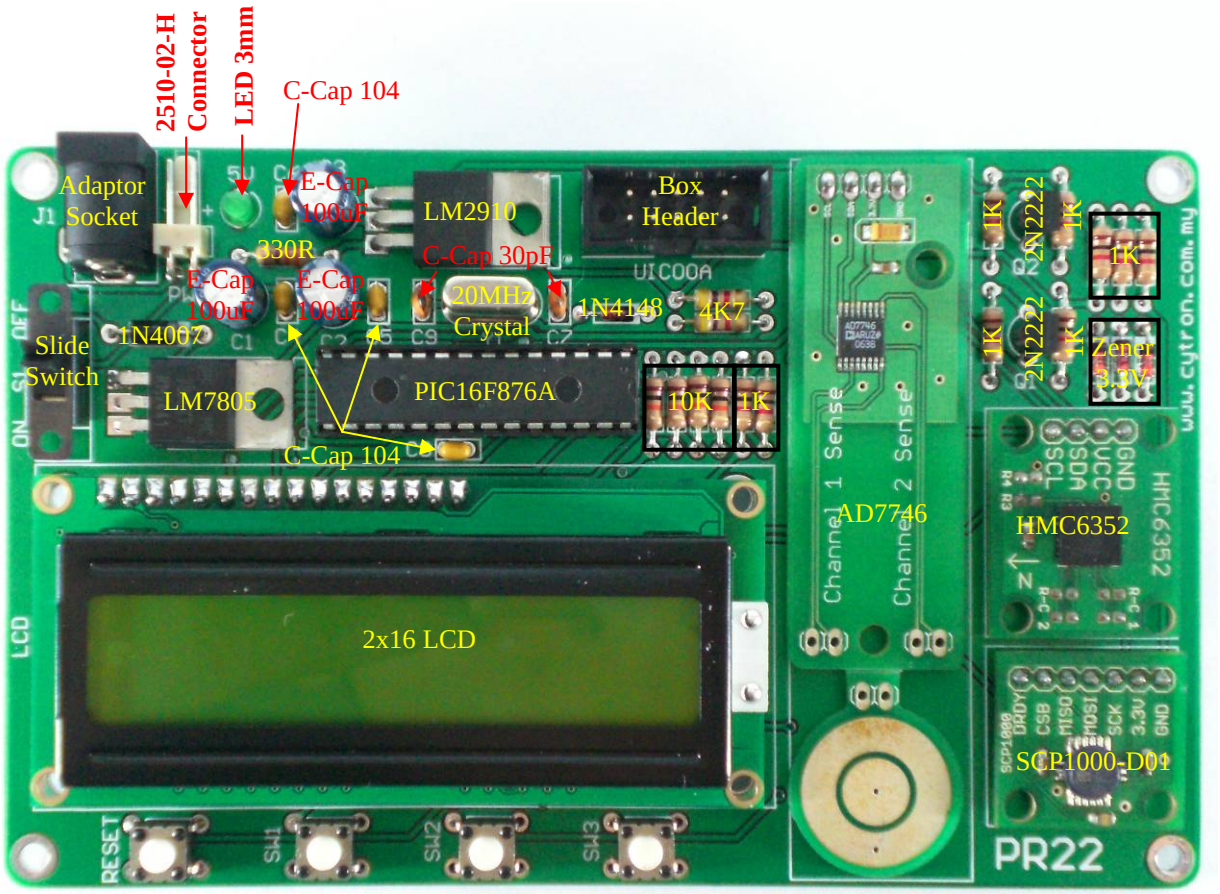
1. After power is connected and switched ON, LCD will display
   Cytron Tech.
   PR22
   After some delay LCD will display:
   Sensor: HMC6352
   OK
2. Press SW1 to decrease mode.
3. Press SW2 to increase mode.
4. Press SW3 to execute current mode.

WARRANTY

No warranty will be provided as this is DIY project. Thus, user is advice to check the polarity of each electronic component before soldering it to board.

Appendix A

PCB Layout:



*** Cytron Technologies reserved the right to replace the component in the list with component of the same functionality without prior notice.**

***2910-3.3V replaced with LM1117T- 3.3V.**

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